VELOCITY AND TURBULENCE MEASUREMENTS IN A 1.5 STAGE TRANSONIC TURBINE

Tolga Yasa, Turkey
Supervisors: R. Dénos & G. Paniagua

The high-pressure (HP) turbine forms with the compressor the core of a gas turbine engine and is a major contributor to the cost and size of an aero-engine. The higher-pressure ratio causes stronger potential and shock interactions that penalize the aerodynamic performance of the rotor but also may cause problems of high-cycle fatigue on the HP stage and on the next stator. In this study, unsteady flow velocity is investigated using hotwire anemometry in a compression tube test facility that has 1.5 stage transonic turbine at the test section. Due to the non-isothermal flow conditions during the test duration, a new technique is developed for the hotwire and is validated.

The tests are carried out in the large VKI compression tube short duration facility CT3. The turbine has two stator rows, each with 43 airfoils, and one rotor with 64 blades. The test facility is able to reproduce the operating conditions of modern HP turbine stages. The Reynolds number is 106 and nominal rotational speed is 6500 RPM. Two different planes are investigated, at the inlet of the turbine, and downstream of the rotor

The preliminary tests are performed in a free jet facility to determine random unsteadiness of the velocity, pressure and temperature. Turbulence intensity, velocity microscale and macroscale profiles are measured. The effect of the sampling frequency on the turbulence measurements is investigated in the jet.

In the facility, turbulence intensities and velocity profiles are investigated in the inlet and the exit of the stage and the periodic fluctuations due to rotor blade passing events at the exit of the stage are determined using a phase-Iocked average technique. Using the phase-Iocked averaging, velocity distribution along the pitch wise direction also calculated. Micro and macro scales are determined in the stage inlet.

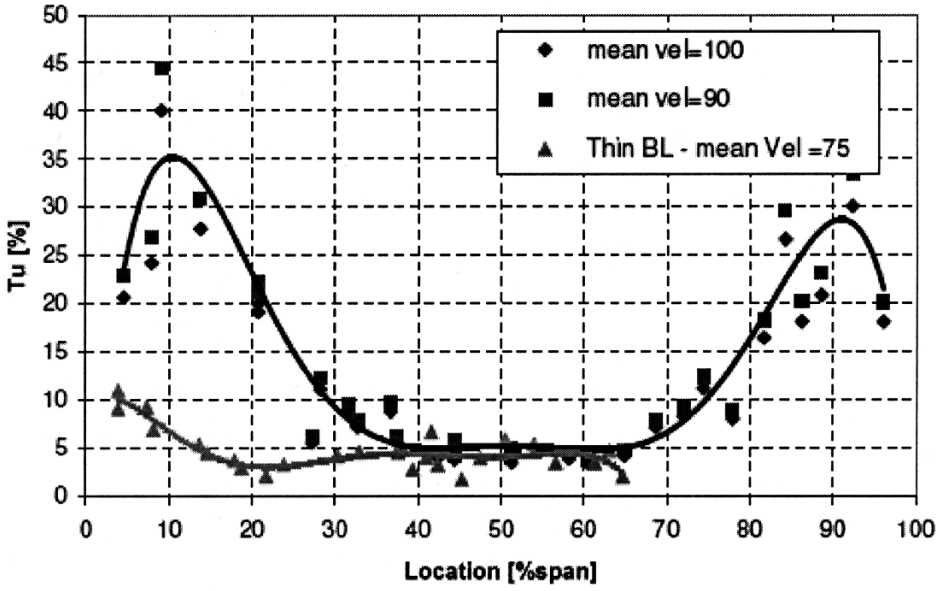

Figure 1: Turbulence intensity at the stage inlet